International Journal of Electrical and
Electronics Engineering Research (IJEEER)
ISSN (P): 2250-155X; ISSN (E): 2278-943X
Vol. 9, Issue 1, Jun 2019, 23-28

AN ENERGY AUDIT OF AN INDUSTRY: A CASE STUDY

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ABSTRACT

India is a developing country and electrical energy consumption byindustries is about 60% of the total energy consumption. The industrial development in the country is progressing at a fast pace due to the increase in the number of industries, the gap between demand and supply of electricity is also increasing day by day. To minimize this gap the best solution is to conductan energy audit of all industries on regular bases. The energy audit will determine energy wastage and losses, and provide techniques and ways to minimize the losses. The energy consumption techniques suggested by the energy audit will not only minimize the losses but also reduce monthly electricity bill. This paper suggests ways and means to conduct an energy audit in an industry

KEYWORDS: Energy Audit, Energy Consumption, Energy Conservation, Power Factor Surcharge, Payback Period, Energy Audit Phase & Energy Conservation Opportunities (ECOs)

Received: Dec 12, 2018; **Accepted:** Jan 02, 2019; **Published:** Jan 29, 2019; **Paper Id:** IJEEERJUN20193

A CASE STUDY

1. INTRODUCTION ENERGY

Audit is defined as the verification, monitoring and analysis of energy use, including submission of technical report containing all the recommendations for improving energy efficiency with cost analysis and an action plan to reduce consumption [1]. In general energy audit is the translation of conservation ideas into realities by lending technically feasible solutions with economics and other organizational considerations within a specified time frame [2]. The energy audit was conducted at Laxmi sales and services, 1325/ 43, ShivajiUdayamnagar, Kolhapur- 416008, Maharashtra, India. The energy audit was conducted within a period of one week. The above industry does the repair and maintenance of pumps, motors, etc. of their own production and also sales the motors and pumps, essential for agriculture and domestic purpose. This industry has a sanctioned load at 440V, is 6kW and it comprises of different sections like service department, spare department, office and printing home. It has many types of equipment and heavy machinery like grinder, drill machine, lathe machine, press machine, submersible pump, welding sets.

2. MAIN OBJECTIVES

The proposed work will cover following sections.

2.1 Audit Phase- I (Pre-Audit Phase)

During pre-audit phase the following observations/inspection were completed within two days as per the schedule given in Table 1.

Table 1: Schedule of Energy Audit Phase -I

S. No.	Observations/ Inspection	Result
1	A complete walk through in the industry	Done
2	Discuss advantages of energy audit	Done
3	Inspect various sections for any energy wastage	Done
4	Prepare a list of major energy consuming machinery with their ratings	See Table-2
5	To identify Instruments required for audit	See Table-3
6	Calculate lighting and machine load	See Table-4
7	Check any loose connection and leakage	No any loose connection and leakage
8	Prepare a visual inspection report	See Table-5
9	Suggestion and ECOs for Pre-audit Phase-I	See Table-6

Table 2: Machines and Equipment in Industry

S. no	Name of Machine/ Equipment	Quantity	Capacity
1	Grinder	1	750W
2	Lathe machine	1	750W
3	Drill machine	1	1075W
4	Press machine	1	1075W
5	Submersible pump	1	1500W
6	welding sets	5	8 kW each

Table 3: Instruments Required for Energy Audit

Sr No	Name of Instruments
1	Digital Multimeter
2	Digital Techometer
3	Clip on meter
4	Lux meter
5	Power factor meter

Table 4: Lighting Load Calculation of Laxmi Sales and Services

S. No	Type of Load	Office	Service Department	Spare Department	Printing Home	Cabin	Open Space
1	CFL (40W)	15	10	14	3	44	3
2	Fan(1 00W)	11	6	2	4	11	-
3	Printer (800 W)	6	1	1	-	-	-
4	Xerox machine(10 00W)	1	-	-	-	-	-
5	Computers (25W)	15	3	2	-	11	-
6	AC (1000 W)	-	-	-	-	11	-
7	Projector(1 500W)	-	-	-	1	-	-
8	**Total load in watts**	7875W	1875W	1610W	2020W	14135W	120W

Total lighting load=7875+1875+1910+2020+14135+120 =27935W

Table 5: Machine Load (Connected) Calculation of Laxmi Sales and Services

S No.	Machine	Load in Watts
1	Grinder	750W
2	Lathe machine	750W
3	Drill machine	1075W
4	Press machine	1075W
5	Submersible pump	1500W
6	Welding sets	40000W
	Total Machine Load	45150W

Table 6: Visual Inspection Report of Pre-audit Phase-I

S No.	Deficiency found in the Industry
1	30 tubes connected with traditional chokes.
2	Tubes in the cabin were ON even inthe day.
3	Deficiency of proper ventilation in the service department

Table 7: Suggestion and ECOs for Pre-audit Phase-I

S No.	Suggestion for Pre-Audit Phase 1
1	Replacing with ballast choke
2	Switching off the tubes when not required
3	Adding number of tubes in service department

Table 8

S No.	Month	Power Factor	Energy Consumption in kWh	Electricity Bill
1	October 2017	0.87	4589 kWh	22947.75rs
2	November 2017	0.86	5000 kWh	25000rs
3	December 2017	0.87	4986	24930rs
4	January 2018	0.895	3600	18000rs
5	February 2018	0.880	3719	18595rs
6	March 2018	0.86	4000	20000rs
7	April 2018	0.854	5960	29800rs
8	May 2018	0.844	3012	15060rs
9	June 2018	0.87	4033	20165rs
10	July2018	0.89	4123	20615rs
11	August 2018	0.81	3258	16290rs
12	September 2018	0.88	3698	18490rs

2.2 Audit Phase-II

During audit phase II the following observationswerecompletedwithin2days. The summary of electricity bills of 12 months since October 2017 to October 2018.

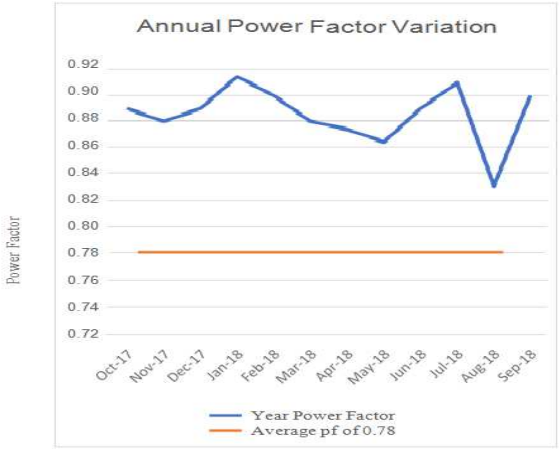

Figure 1: Power Factor v/s Months

Figure 1 shows the monthly power factor variation in a year.

2.3 kVAr Calculation for Industry

According to the electrical data given below the required kVAr or capacitor bank can be calculated to maintainthepower factor of 0.95 to reduce the powerfactor surchargebecausetheelectricalutilityshall be apply a power factor clause for those consumers who have not maintain the average power factor of 0.90. In case the average power factor falls below 0.9(90%), a surcharge @1% of energy charges for every 0.01(1%) fall in average power factor below 0.90(90%), shall be charged. Also, an incentive of 1% of energy charges shall be provided if power factor is above 0.95(95%)foreach0.01(1%)improvementabove 0.95(95%) [5].

Average power factor (during the year October 2017 to September 2018) = 0.78 (Referring Figure 1)

Required power factor = 0.95. The power factor is defined as the ratio of true or real power in kW to apparent power in kVA.

Therefore, Power factor ($\cos\Phi$) = kW/kVA (1)

$$(KVA)^2=(KW)^2+(KVAR)^2$$

$$KVAR=\sqrt{(KVA)^2-(KW)^2} \quad (2)$$

The required kVAr can be calculated from the above equation 2. If the power factor is improvedfrom0.78to0.95thiswillreduce the power factor surcharge. The required kVAr or capacitor bank can be calculated from the Figure2 givenbelow.

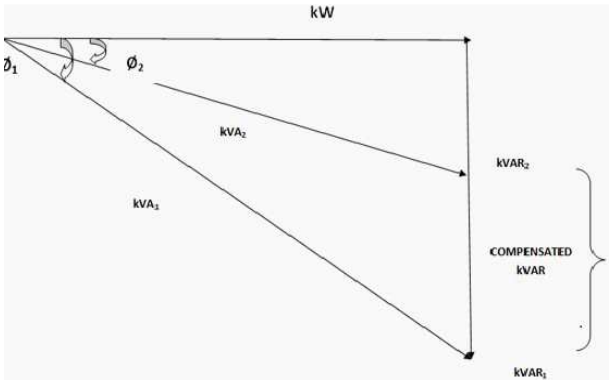

Figure 2: Power Factor Correction

The required kVAr will be calculated as under tan ϕ1= AC/OA, OA = P (kW).

Therefore, AC= Ptanϕ1 And AB= Ptanϕ2, BC=AC–AB, put the values weget

BC =P tanϕ1 -P tanϕ2 and BC = Q(kVAr)

Q(kVAr)=P(tanϕ1-tanϕ2) (3)

Put the values of P = 96.98

Q (kVAr) = 96.98 [tan (38.73) – tan (18.194)] Q (kVAr)

=46.044, say47kVAr

(approximately)

2.4 Calculation of Payback Period for Implementation of ECOs

- Annual energy savings (due to replacement of ballast)

  = [30 (T.L) x40(W) x12(hr) x365(d) x7.5

  (Rs/kWh)] / 1000

  =39420Rs

  where,

  T.L = tube lights

  W = wattage of each traditional chokes hr = no. of hours in a day

  d = total no. of days in a year Rs/Kwh = rate of each unit

- Income from selling of old traditional chokes

  = 30x @Rs50 = Rs 1500

  TotalInvestmentwillbe=TotalInvestment on Hardware - Income from Selling Old Chokes

  =39420-1500

  Total Investment=37920rs Net Savings will be=39240rs

We know that Payback period in year willbe given as=$\frac{Total\ Annual\ Investment}{Net\ Annual\ Savings}=\frac{37920}{39240}$

Total Payback period=0.966 years Payback period in months = 0.966 x 12=11.59=12

3. CONCLUSIONS

- The payback period of the energy audit programmed for Laxmi sales and services industrywillbe12 months; implementation of ECOs is being carried out and will be completed by late year2019.
- It is believed that energy audit is one of the most comprehensive methods in achieving energy savings in industry thus reducing excessive energy consumption if all private sector participates in the implementation of the energy audit programs in their industry so that, wasteful consumption of energy will beminimized.
- The replacement of traditional welding sets with IGBT welding sets is not beneficial to the factory, no doubt they operate at good p.f and small initial current but their cost and the maintenance cost is also very high that increases in thepayback period.
- The implementation of energy saving measures suggested in this paper is solely dependent upon the decision of the management of the factory. Several ECOs that are cost effective are not often implementedduetolackofinternalfunding such as installation of IGBT weldingsets.

4 ACKNOWLEDGMENTS

I would like to express gratitude to Laxmi sales and services for providing this opportunity in conducting the audit.

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